# Multifidelity multilevel Monte Carlo for approximate Bayesian computation

*David Warne*
School of Mathematical Sciences, Queensland University of Technology, Australia.

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**Abstract**
Models of stochastic processes are widely used in almost all fields of science. However, data are almost always incomplete observations of reality. This leads to a great challenge for statistical inference because the likelihood function will be intractable for almost all partially observed stochastic processes. As a result, it is common to apply likelihood-free approaches that replace likelihood evaluations with realisations of the model and observation process. However, likelihood-free techniques are computationally expensive for accurate inference as they may require millions of high-fidelity, expensive stochastic simulations. To address this challenge, we develop a novel approach that combines the multilevel Monte Carlo telescoping summation, applied to a sequence of approximate Bayesian posterior targets, with a multifidelity rejection sampler that learns from low-fidelity, computationally inexpensive, model approximations to minimise the number of high-fidelity, computationally expensive, simulations required for accurate inference. Using examples from systems biology, we demonstrate improvements of more than two orders of magnitude over standard rejection sampling techniques.

## References

[1] D.J. Warne, T.P. Prescott, R.E. Baker, M.J. Simpson. Multifidelity multilevel Monte Carlo to accelerate approximate Bayesian parameter inference for partially observed stochastic processes. ArXiv: 2110.14082, 2021.